LAr TPC mechanics Workshop

Thoughts and issues to get us started

R. Rucinski, FNAL

General direction

- 2 high x 7 rows X 28 . C A C A C A C
  - 168 total APA's   224 Cathode PA's
- APA's/CPA's suspended from above rails.
- Load APA down hatch, hold, attach to bottom of next one, attach to rail, roll into position.
- Rails run length of cryostat (70 meters)
- Rails need support from above (3 m pitch)
- Do we gang 7 rails together with cross rails?
  - Lose height, adds weight, but decreases penetrations.
- Support rods tie to something independent of the roof.
  - Truss that spans across, drip shield, cavern

Some issues

- The penetration through the cryostat roof has a flexible bellows in it so
  - a.) that the vertical load of the TPC's and rails are not transmitted to the roof of the cryostat and
  - b.) the motion of the roof during pressure variations is not transmitted to the rods.
- The distance between the nozzle penetrations shouldn't change when the cryostat is cooled down because the cryostat membrane has corrugations in it that unfold. However, the length of the rails and any cross members would change as the cryostat is cooled down.
- The vertical section of the rod inside the cryostat should be designed for small conductive heat load. It will be a tension member. Maybe a fiberglass section. The vertical length would change as it gets cold but since it would be the same for all, the TPC frame elevations would just change by a small amount.
- Installation, need access 14 meters up with a narrow space and delicate wires on either side. – Joe Howell has been investigating this.

Fox, Walter R [foxw@indiana.edu]

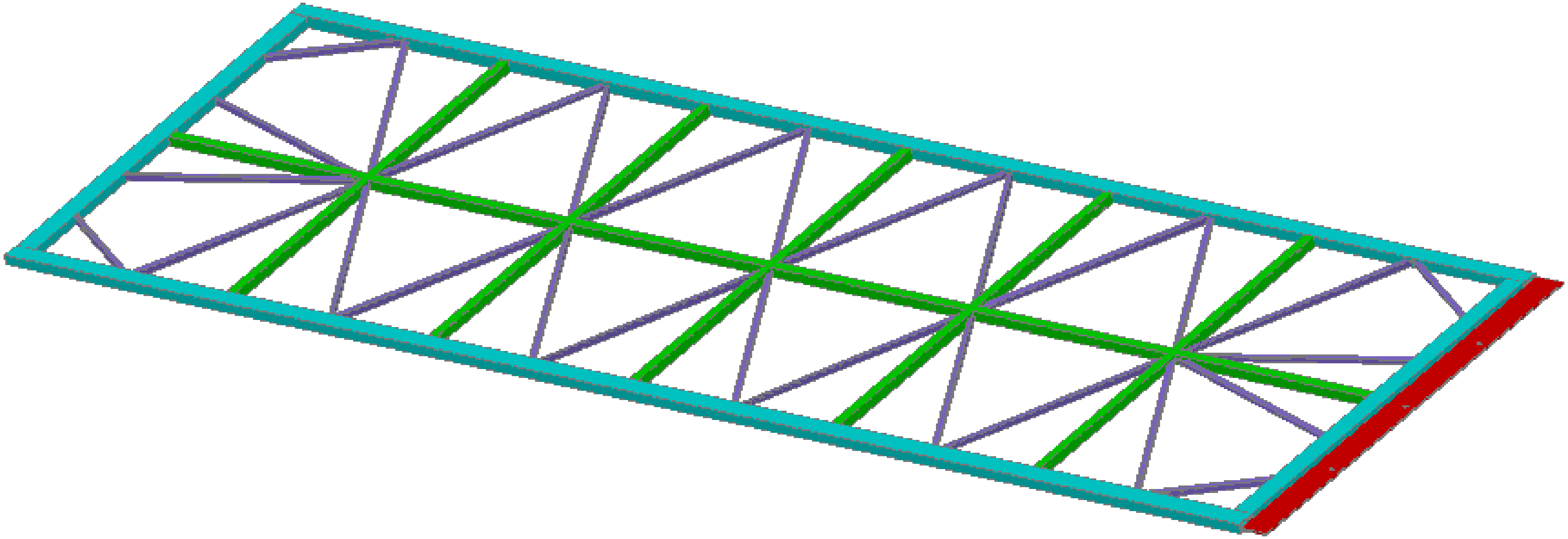
I have been turning these concepts over in my head, mostly trying to imagine installation techniques and procedures given the structures envisioned.

One of the immediate problems with multiple supports on a member with a distributed load (a rigid 1d beam is completely determined by 2 supports and a 2d panel/plate by 3) is that in order to assure uniform loading on each tension member, their lengths needs to be empirically adjusted at installation. While this is possible, once the support beam cools and contacts, the distance between attachment points decreases with the end points moving in the most. The links toward the ends are then stretched and take up proportionally more of the load. The simplest way to reduce this effect is to have links much longer than the max deltaL due to contraction so the change in tension is very small. Another way is to use a single cable strung thru a series of pulleys so that the supported points can move and the cable tension remains constant. This really is the fundamental problem; how to provide structural support from the cold elements to warm ground but still insulate and allow for differential contraction.

Probably the best possible way around this is not to have a beam supporting the TPC's at all but use cables at the corner of each vertical pair with pivoting links 'loosely' connecting adjacent modules. This has the advantage of having a fully determined support, greatly minimizing structural materials and allowing at least some free movement between modules for contraction. The disadvantages are that you now have support cable penetrations every 2.5m in each direction and you necessarily need a VERY robust lifting vehicle to pick up the vertical pair, drive it over the membrane floor to its installation point with personnel up at the top to connect the support cables and data wires/fibers.

Cryogenic compatible Material	Delta L/L 293 K to 1K	Delta L/L 293 K to 90K	293 K to 90 K Delta/7 meter (mm)	293 K to 90 K Delta/10 meter (mm)	293 K to 90 K Delta/70 meter (mm)
Invar, 36% Ni, 3.0 Mn, bal. Fe (Supplier sht)	4.00E-04	4.00E-04	2.8	4.0	28.0
Invar, 42% Ni, 0.8 Mn, bal. Fe	5.20E-04	*4.99E-04*	3.5	5.0	34.9
Glass, approximate, 293K to 80 K	1.00E-03	*9.20E-04*	6.4	9.2	64.4
Beryllium	1.31E-03	*1.21E-03*	8.4	12.1	84.4
Niobium	1.43E-03	*1.32E-03*	9.2	13.2	92.1
Tantulum	1.43E-03	*1.32E-03*	9.2	13.2	92.1
Titanium (6A14V) 300 to 4.2, CDF ref.	1.54E-03	*1.42E-03*	9.9	14.2	99.2
Platinum	1.95E-03	*1.79E-03*	12.6	17.9	125.6
Iron (Questionable for < 245 K)	1.98E-03	1.85E-03	13.0	18.5	129.5
Nickel	2.24E-03	2.11E-03	14.8	21.1	147.7
Inconel, 80% Ni, 14%Cr, 6% Fe	2.29E-03	*2.11E-03*	14.7	21.1	147.5
Monel	2.51E-03	2.30E-03	16.1	23.0	161.0
Constantan, 50% Cu, 50% Ni	2.69E-03	*2.47E-03*	17.3	24.7	173.2
304 Stainless Steel	2.96E-03	2.71E-03	19.0	27.1	189.7
316 Stainless Steel	2.97E-03	*2.73E-03*	19.1	27.3	191.3
beryllium copper, 2 Be, o.3 Co, bal. Cu	3.16E-03	*2.91E-03*	20.4	29.1	203.5
Copper	3.26E-03	*3.00E-03*	21.0	30.0	209.9
Yellow Brass 65%Cu, 35% Zn	3.84E-03	*3.53E-03*	24.7	35.3	247.3
Silver	4.13E-03	*3.80E-03*	26.6	38.0	266.0
Aluminum	4.15E-03	*3.82E-03*	26.7	38.2	267.3
Tin, white tin as opposed to grey	4.47E-03	*4.11E-03*	28.8	41.1	287.9
Soft Solder, 50% Pb, 50% Sn	4.67E-03	*3.97E-03*	27.8	39.7	277.9
Magnesium	4.90E-03	4.41E-03	30.9	44.1	308.7
Zinc	6.83E-03	*5.81E-03*	40.6	58.1	406.4
Indium	7.06E-03	*6.00E-03*	42.0	60.0	420.1
Lead	7.08E-03	5.52E-03	38.6	55.2	386.4
Kel-F	1.14E-02	*9.65E-03*	67.5	96.5	675.3
Teflon	2.14E-02	*1.82E-02*	127.3	181.9	1273.3
G-10, Warp direction	2.50E-03	2.10E-03	14.7	21.0	147.0
G-10, normal direction	7.10E-03	6.20E-03	43.4	62.0	434.0

Frame – courtesy of Bo Yu



Courtesy of Walt Fox